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I.—*On the Contributions to the Anatomy and Classification of Birds made by the late Prof. Garrod, F.R.S.* By W. A. Forbes, B.A., Fellow of St. John's College, Cambridge, Prosector to the Zoological Society of London.

It having been suggested to me by one of the Editors of this Journal that a concise *résumé* of the ornithological papers of my late friend and predecessor, Prof. A. H. Garrod, F.R.S., would not only form an appropriate memoir of him, but would also be useful to those ornithologists who are interested in the anatomy of birds and the questions of classification that depend on it, I have endeavoured in the present paper to give a short sketch of the contributions Prof. Garrod made to our knowledge of, and of his views on these points.

In the seven years (1872–1879) during which Prof. Garrod held the post of Prosector to the Zoological Society, no less than thirty-eight papers from his pen (all, with one exception*, published in the Zoological Society's 'Proceedings') appeared, dealing with various points in the anatomy or physiology of birds. Of these a complete list will be found in the January number of this Journal for last year*. All of these, except two†, are morphological in nature; but many of the characters of birds from the physiological side were fully expounded in his series of Fullerian Lectures at the Royal Institution and elsewhere. At the time of his death Prof. Garrod was also engaged on an article on the mechanism of flight; for his wonderful mechanical skill enabled him to explain and demonstrate this and other physiological problems in a method but rarely to be met with amongst biologists generally. But this, unfortunately, he left in an unfinished condition.

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* "Note on some of the Cranial Peculiarities of the Woodpeckers," Ibis, 1872, p. 357.

In the present article I propose first to consider those points in the anatomy of birds first brought into notice, or worked out in large groups, by Garrod, and secondly to consider the light thrown by these facts on the correct collocation of various genera, or larger groups, as well as on the arrangement of these latter into groups of a still higher power. But I shall avoid, as far as possible, any comparisons with previously proposed classifications, as it is not my wish to enter, in this place, into discussions of that kind. Under each of these headings I shall endeavour, as far as is consistent with clearness and conciseness, to preserve a chronological order.

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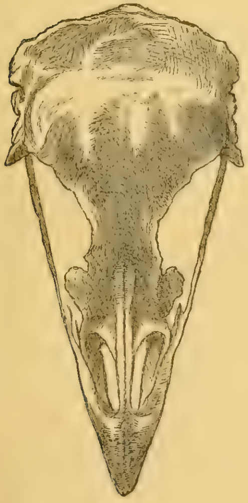
* In addition to his published papers on birds, Prof. Garrod was engaged, as probably many of the readers of 'The Ibis' are aware, on a general account of the Anatomy of Birds, to be published in three fasciculi. As originally planned, the first fasciculus of this work was to contain a complete account of the anatomy (not including the histology) of the common Fowl, as a type of all birds; the second was to be occupied with a comparative account of the "soft parts" in the different groups; whilst the third was, I believe, to have been devoted to osteology and a consideration of the results arrived at as regards classification. Of these three fasciculi, the first was nearly completed at the time of his death, and the second left about half done, nearly all the groups of the "Homalogonatous" birds being treated of in it, together with some of the remaining ones. The MS. of both of these portions has been, fortunately for our science, preserved; and it is my hope some day to complete the work for publication in a form worthy of its original author.

† "On the Mechanism of the Gizzard in Birds," P. Z. S. 1872, pp. 525-529; "On a Point in the Mechanism of the Bird's Wing," P. Z. S. 1875, pp. 82–84.

I. *On the Conformation of the Nasal Bones**.

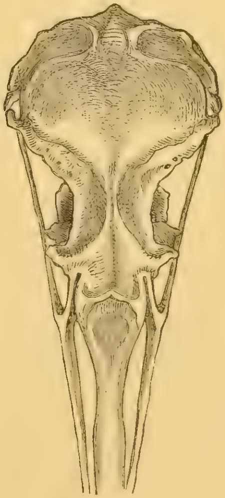
"In most birds the anterior margin of the nasal bone is concave, with the two cornua directed forwards," these processes being "continuous behind with the body of the bone and with one another, there being no interruption of any kind between them. Such a condition is found in *Otis* and the Gallinæ proper; and birds possessing the bone so constructed may be termed *holorhinal*: in them a transverse straight line, drawn on the skull from the most backward point of the external nasal aperture of one side to that of the other, always passes in front of the posterior terminations of the nasal processes of the præmaxillæ." This simply concave nature of the posterior margin of the osseous external nares, as well as the relations of the extremities of the nasal bones to those of the nasal processes of the præmaxillæ, is shown in the subjoined figure of the Fowl's skull (see fig. 1).

Fig. 1.



Skull of *Gallus domesticus* (from P. Z. S. 1873, p. 35, fig. 9).

Fig. 2.



Skull of *Larus argentatus* (from P. Z. S. 1873, p. 34, fig. 2).

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* "On the Value in Classification of a Peculiarity in the Anterior Margin of the Nasal Bones in certain Birds," P. Z. S. 1873, pp. 33–38.

In a large number of birds, however, the condition of things is different, as will be evident from an inspection of a similar view of a Gull's skull (*Larus argentatus*).

Here (see fig. 2) the posterior margin of the osseous nares has a distinctly slit-like or triangular form, instead of being simply concave; hence the birds presenting this peculiarity, which varies to some extent in the degree of its development in different forms, may be called "*schizorhinal.*" In most of these *schizorhinal* forms the line joining the posterior extremities of the nostrils passes *behind*, instead of in front of, the ends of the nasal processes of the præmaxillæ. When the beak becomes shortened and broad at the base, however, as, *e. g.*, in the Pteroclidæ, this feature nearly disappears. Birds belonging to the *schizorhinal* group are nearly all, with the exception of *Platalea* and *Ibis*, "*schizognathous*," as regards their palate. The "Schizorhinæ" comprise the following minor groups:—Columbidæ, Pteroclidæ, Turnicidæ, Parridæ, Limicolæ (except *Œdicnemus*, which is holorhinal, therein agreeing with the Bustards), Laridæ, Gruidæ, Eurypygidæ, Rhinochetidæ*, Plataleidæ (the *Hemiglottides* of Nitzsch), and Alcidæ. *Aramus* also, as shown by Prof. Garrod's later investigations†, must be included here, being schizorhinal, like the Cranes. All these birds, it may be noticed, belong to the *Homalogonatous* series, possessing, at least normally, the *ambiens* muscle, presently to be referred to. In 1877 Prof. Garrod discovered that a similar conformation of the skull, as regards these bones, obtains in certain of the South-American "Formicarioid" Passeres—that is, in *Furnarius* and some of its allies‡ (*Leptasthenura, Synallaxis, Sclerurus,* and *Phlœocryptes*), as may be seen in fig. 3, where that of

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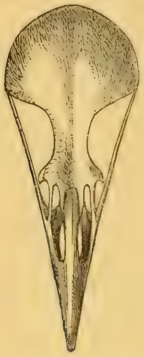
* To these may be added, as I have Prof. Garrod's authority for doing, *Mesites*, as is shown by M. A. Milne-Edwards's investigations (*v.* Ann. Sc. Nat. ser. 6, vii. art. no. 6). The Rallidæ, with which that naturalist associates *Mesites*, are all *holorhinal*, at the same time that they lack the powder-down patches of *Mesites, Rhinochetus,* and *Eurypyga.*

† P. Z. S. 1876, p. 275.

‡ "Note on the Anatomy of Passerine Birds.—Part II.," P. Z. S. 1877, pp. 449–452.

Fig. 3.



Skull of *Furnarius rufus*, showing its schizorhinal character (from P. Z. S. 1877, p. 450, fig. 3).

Furnarius rufus is represented. Referring to this, he says, "It has been my habit to group all the birds possessing a schizorhinal skull in a single major division . . . but the independent development of an identical disposition in the small division of the Passerine birds above mentioned weakens the importance of the character to a certain extent, although it is not at all necessary to assume that it overthrows its significance. Collateral evidence, from visceral and other details, compels me still to think that those schizorhinal birds which possess the ambiens muscle, or are, in other words, homalogonatous, must be retained in one great order, *Charadriiformes,* until some important structural differences are discovered which necessitate their being otherwise arranged. The schizorhinal disposition is most certainly one which is a secondary development upon the normal holorhinal one; and that it has been independently arrived at in two non-related orders of the class is proof that it results from most simple causes, because the *probability* that the same complex conformation should appear, *de novo,* varies inversely as the complexity; the greater the elaborateness the less the chance that it, in all its detail, comes into existence more than once."

II. *The Carotid Arteries.*

The variations in the position of the carotid arteries in birds had been studied by Meckel, Bauer, Barkow, and others; but their opportunities of observation were limited, for the most part, to European species. Prof. Garrod, in his paper on the subject*, has recorded their condition in 400 species of birds, of 300 different genera; in his subsequent papers, or MS. notes, many additional species are included.

From a consideration of these, six different modifications in the disposition of these vessels may be traced:—

(1) The two carotids, each springing, as usual, from the innominate artery of its side, after the latter has given off the pectoral and subclavian branches, run up in a converging manner into the neck, and then continue, closely parallel to but quite free from one another, up along the under surface of the neck, in a bony canal or passage formed by the hypapophyses of the cervical vertebræ, to near the head, where they again diverge and break up for the supply of that part. This may be considered the most typical and least modified form: it is present in a very large number of birds.

(2) Where, instead of both carotids being developed, only one, the left, is so, the right having entirely disappeared. This is a condition constant in all Passeres, as well as in sundry other birds.

(3) Where the right artery is present in its normal position in the hypapophysial canal; but the left runs up the neck superficially in company with the left jugular vein and *vagus* (pneumogastric) nerve. This condition is present only in certain Parrots.

(4) Where the two arteries, instead of running parallel, *blend* together at the lower part of the neck, running up then as a *single* trunk in the normal position till its bifurcation near the head. This is an exceptional condition. The two trunks before blending may be equal in size (*Botaurus stellaris*), or either the right (*Phœnicopterus*) or the left (*Cacatua sulphurea,* according to Meckel†), may be the bigger.

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* "On the Carotid Arteries of Birds," P. Z. S. 1873, pp. 457–472.

† Prof. Garrod was unable to confirm this statement in the only specimen dissected by him (P. Z. S. 1874, p. 588).

To these four conditions, duly noticed in Prof. Garrod's paper above quoted, may be added two more:—

(5) When the *right* carotid only is present, as is the case*, as discovered by him, in the Bustards of the genus *Eupodotis.*

(6) In *Bucorvus abyssinicus,* as discovered by my friend Mr. W. Ottley, who, at Prof. Garrod's request, undertook a reexamination of the question, the two carotid arteries are reduced to fibrous imperforate cords, and their place is taken (functionally) by two vessels which are apparently enormously enlarged equivalents of the *comes nervi vagi* of other birds†.

From these facts it is evident that, taken *per se,* the disposition of the carotid arteries has not much significance amongst birds, there being many families in which, whilst the majority of the species have two, some have only one carotid. This, for instance, is the case with *Toccus* and *Buceros* amongst the Bucerotidæ, *Plotus* and *Phalacrocorax* amongst the Steganopodes, *Cypselus* and *Cypseloides* in the Swifts, &c.: in all these cases the first-named genera have but *one,* the others two, carotids. In other cases, however, the characters of the carotids hold good through very large groups: thus no Passerine bird has ever yet been found with more than a left carotid, and no Pigeon, Duck, or Bird of Prey without two normally placed ones.

III. *The Disposition of the Vessels of the Thigh.*

In Man and other Mammals, so far as I am aware, the main nerve of the leg is the sciatic; the main artery and vein are the *femoral,* running in the front of the leg. In birds, as a rule, the main artery accompanies the *sciatic* nerve, running close above and parallel to it; the vein remains the femoral.

To these rules certain exceptions were first pointed out by

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* P. Z. S. 1874, p. 473.

† "On a Peculiarity in the Carotid Arteries and other Points in the Anatomy of the Ground-Hornbill," P. Z. S. 1876, pp. 60, 61. Also "A Description of the Vessels of the Neck and Head in the Ground-Hornbill (*Bucorvus abyssinicus*), by W. Ottley, F.R.C.S.," P. Z. S. 1879, pp. 461–467.

Prof. Garrod. Thus, in *Centropus phasianus*[*], though *not* in *Centropus rufipennis*, or any of the other Cuculidæ examined by him, as well as in all the species of Pipridæ and Cotingidæ, eight in number, dissected (except *Rupicola crocea*), the main artery of the leg accompanies the femoral vein: it is a *femoral* artery[†].

Again, in *Dacelo gigantea* and *D. cervina*[‡], the femoral vein is replaced by one which lies between its normal position and the sciatic artery, crossing over, instead of under, the femoro-caudal muscle; and the same is the case, as recorded by him in an unpublished (and, unfortunately, unfinished) paper "On the Anatomy of *Pelecanoides*," in that singular form of Petrel. These two cases are, I believe, the only ones yet recorded of this unexpected arrangement.

IV. *The Muscles of the Thigh*[§].

The myology of birds was always one of Prof. Garrod's favourite subjects; and of his various myological papers, the two enumerated below may fairly be considered the most important, as from the facts detailed therein he drew up, *in part*, the only detailed scheme of a classification of birds ever published by him.

In the region of the thigh of birds there are six muscles, which may or may not be present, though no known bird wants them all. These six muscles are the *ambiens*, the *gluteus primus*, the *semitendinosus*, the *accessory semitendinosus*, the *femoro-caudal*, and the *accessory femoro-caudal*[||].

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[*] P. Z. S. 1873, p. 629, note.

[†] Since writing the above, I have found the same to be the case in my specimens of *Corythaix persa* (two), *C. porphyreolopha*, and *C. erythrolopha*, and in *Musophaga violacea*. In *Schizorhis africana* (two), however, the normal condition persists.

[‡] P. Z. S. 1873, p. 629.

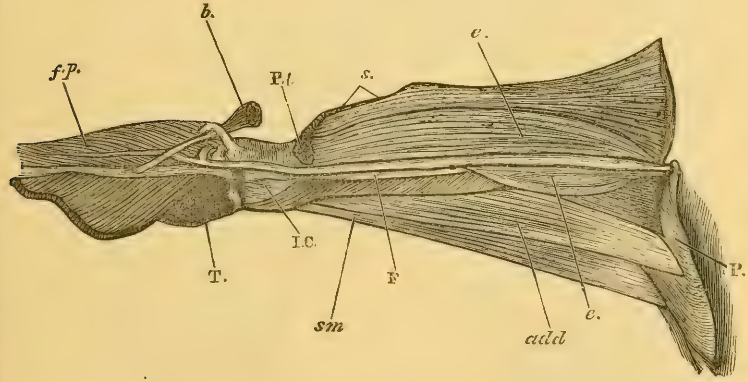
[§] "On certain Muscles of the Thigh in Birds, and on their Value in Classification.—Part I.," P. Z. S. 1873, pp. 626–644; "Part II.," P. Z. S. 1874, pp. 111–123, pl. xvii.

[||] It is not my object in this paper to discuss the homology of the muscles here so named with those of other Vertebrata.

These will here be all considered seriatim; they may all, it may be mentioned, be well seen in the common Fowl.

(1) The *ambiens*.—This muscle, unlike the others to be subsequently mentioned, lies on the lower or inner surface of the thigh. As generally developed, it is a more or less slender fusiform muscle, which, arising from the præpubic spine or process of the pelvis, close in front of the acetabulum, runs along the inner side of the thigh superficially, and then, turning slightly outwards, runs, as a thin tendon, in the fibrous tissues covering the knee-joint (in some cases perforating the *patella*) to the outer side of the leg, and terminates there by joining one of the tendons of the superficial flexor of the toes, the *flexor perforatus digitorum*. The course of this muscle will be made clear by the accompanying representation of it, as seen in a Touraco (*Corythaix erythrolopha*). In one or two cases (e.g. *Œdicnemus, Stringops*) it tends to become obso-

Fig. 4.



Thigh of Touraco (*Corythaix erythrolopha*) viewed from the inner side, to show the ambiens muscle, arising from the præpubic spine of the pelvis (P), and running along to blend with one of the tendons of origin of the flexor perforatus digitorum (*f. p*). F, femur; *Pt*, Patella; I.C, inner condyle of femur; T, tibia; *b*, biceps (cut short); *s*, sartorius (also cut); *e, e*, extensor femoris; *s m*, semimembranosus; *add*, adductores.

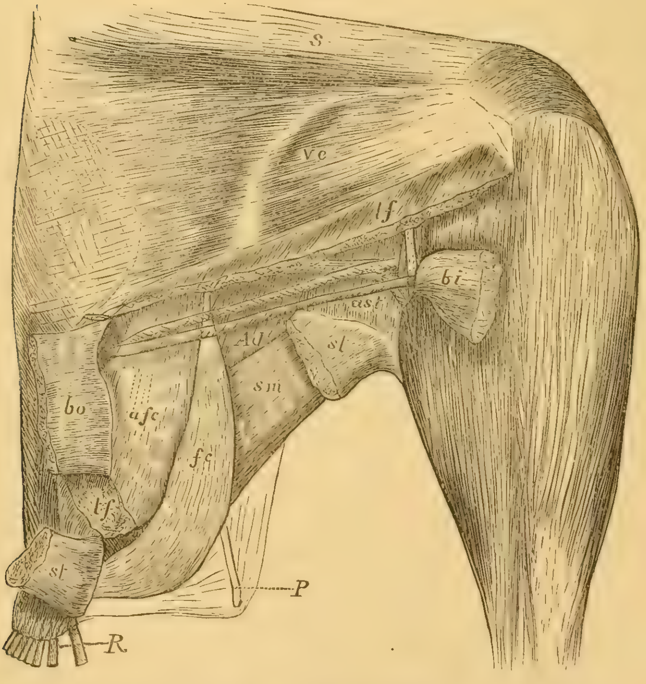
N.B. The surrounding parts have been somewhat distorted from their natural positions to show better the course of the ambiens.

lete after reaching the knee, becoming lost in the capsule of the knee-joint. In all Passerine birds, and some others, it is always absent.

(2) The *gluteus primus.*—In Garrod's earlier papers this muscle is called the "*tensor fasciæ*;" and it is described under that name in the first of the two papers quoted.

Like the four next muscles, this lies on the upper (or outer) surface of the thigh, and with them may be seen in the annexed figure. It is entirely superficial, lying beneath the skin, and not requiring any dissection for its display. More or less triangular in shape, it arises "from the whole length

Fig. 5.



Outer view of right thigh of *Gallus bankiva*, partially dissected (from P. Z. S. 1873, p. 627, fig. 1).

P, pubis; R, rectrices; *s*, sartorius; *v e*, vastus externus; *t f*, gluteus primus (cut) origin and insertion; *b o*, biceps origin; *b i*, biceps insertion; *f c*, femoro-caudal; *a f c*, accessory femoro-caudal; *s t*, semitendinosus, *ast.* accessory femoro-caudal; *Ad*, adductor.

of the postacetabular ridge," as the ridge separating the lateral from the dorsal surface of the postacetabular area of the pelvis may be called, " as well as from the posterior border of the ischium, as far forward as its junction with the pubis." Its fibres converge and become blended with those of the *extensor femoris*, forming with them a broad thin aponeurosis which covers the front of the knee and is inserted into the tibia-head—the patella, when present, being developed in it. The degree of development of this muscle (whose cut surfaces are marked *t f* in fig. 5) varies much in different groups of birds, and in some may be entirely absent, *e.g.* the Bucerotidæ and Palamedeidæ. As a rule, it is not small. In the paper on *Chauna** a table will be found stating the degree of development of this muscle in the greater number of families (*l. c.* p. 199).

(3) The *semitendinosus*.—Generally a broad flat ribbon-shaped muscle, bordering the contour (sometimes together with another muscle, the *semimembranosus*) of the fleshy part of the thigh behind. It arises from the transverse process of the first free coccygeal vertebra, and from the fibrous membrane between this and the ilium ; it is inserted into the inner side of the head of the tibia (at least when the muscle next to be described is absent).

(4) In many birds a " a rhomboidal sheet of muscle, arising from the anterior end of the *linea aspera* " (a muscular line on the under surface of the femur) joins the last-named muscle " anteriorly by an oblique tendinous raphe, which continues down the back of the leg superficially." When present, most of the main *semitendinosus* joins this *accessory* head to be continued down the leg.

(5) The *femoro-caudal*.—This is a thin, narrow, elongated muscle, which is covered above by the *gluteus primus* (if present) and the *biceps cruris*, below by the *semitendinosus*. Arising from the last two coccygeal vertebræ, it is inserted into the *linea aspera* of the femur at about one third its length (in the Fowl) from the trochanter.

(6) In many birds the *femoro-caudal* is joined by an *acces-*

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* "On the Anatomy of *Chauna derbiana*," &c., P. Z. S. 1876, pp. 189–200.

sorius, which arises from the external surface of the pelvis behind the femur, and joins the main muscle, to be inserted with it into the femur, but nearer the head of that bone.

As already mentioned, some birds possess *all* these six muscles, but no bird is known which does not possess at least one. It is a convenient plan to designate the four last-named muscles by the letters X, Y, A, B. Thus a Fowl possessing all four would have a formula A.B.X.Y, the *femoro-caudal, accessory femoro-caudal, semitendinosus,* and *accessory semitendinosus* being all present. On the other hand, a Hawk or Owl, possessing only *one,* the *femoro-caudal,* would have as formula A.

Of these four muscles there are sixteen possible combinations; but of these only eight are actually found in birds*.

Furthermore, if we denote the presence or absence of the *ambiens* muscle by the signs + or −, we obviously get sixteen combinations again, though of these only fifteen have, as yet, been observed. For the sake of brevity it will be useful to remember the above four letters, to save the repetition of the full names. To the bearing of these muscles in the classification of birds, I intend to revert at a subsequent part of this paper, only stating here that species of the same genus and nearly allied genera have, nearly in every case, *the same* myological *formula,* and that in *families* peculiarities involving more than *one* change are rare, further differences indicating a more remote relationship.

V. *The Distribution of the Deep Plantar Tendons*†.

In all birds, whatever number of toes they have, there are two deep *flexor* muscles of the toes, the fleshy bellies of which are situated between the knee and the "ankle," whilst their tendons run along the posterior aspect of the tarso-metatarse. One, arising from behind the external condyle of the femur, is the *flexor longus hallucis;* the other, arising from the posterior aspect of the tibia and from the fibula, is the *flexor perforans digitorum,* so called because its terminal tendons perforate those of the more superficial *flexor perforatus* (the muscle, it will be remembered, joined by the tendon of the *ambiens*). Below the "ankle" the tendons of these muscles run along the tarso-metatarse; whatever their ultimate distribution, they may be easily identified in this region, the *flexor longus hallucis* being always external to, or superficial of, the *flexor perforans* (or both). In all the Passeres, as already noticed by Sundevall (except in the Eurylæmidæ, *vide infrà*), as well as in *Upupa epops* and perhaps one or two Ardeine birds, these two tendons are quite independent of each other, so that if the *flexor hallucis* be artificially pulled no flexion (closing) of the other digits takes place. This arrangement is represented in fig. 6. In all other birds, however, the two tendons, during some part of their course in the tarso-metatarse, are more or less intimately connected together by a fibrous band or *vin-*

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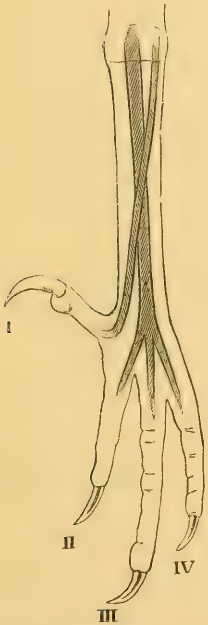
* P. Z. S. 1874, p. 111.

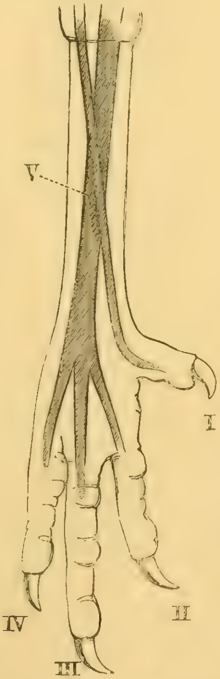
† "On the Disposition of the Deep Plantar Tendons in different Birds," P. Z. S. 1875, pp. 339–348.

Fig. 6.



A typical Passerine foot
(from P. Z. S. 1875, p. 347, fig. 9).

Fig. 7.



Foot of *Gallus bankiva*
(from P. Z. S. 1875, p. 341, fig. 1).

V, Vinculum.

culum, or may even completely blend. It is to a consideration of the varying arrangements produced that this paper of Prof. Garrod's is in the main dedicated; and some of the most important modifications may be noticed here.

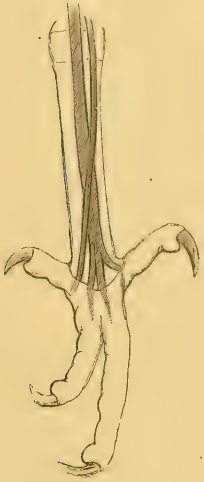
In a large number of birds the type presented by the common Fowl obtains. Here the *flexor perforans* supplies digits II–IV, and the *flexor hallucis* only digit I (the hallux); this, as it crosses the tendon of the *flexor perforans,* sends down a strong fibrous *vinculum* (*vide* fig. 7, V). The proportions of the *vinculum* to the main tendon (that distributed to the *hallux*) vary greatly, as it may or may not be greater than the hallucial portion. In some Birds of Prey a *vinculum* may be combined with a special slip of tendon to digit II, or it may be nearly entirely distributed to that digit. In the Cathartidæ a quite different arrangement, next to be described, obtains. Here, and in many other birds, particularly amongst the *Anomalogonatæ,* the two tendons blend completely, and the tendinous slip to the hallux comes off from the blended tendon, apparently springing from the *inner* side. A slight modification of this produces an arrangement by which the hallucial slip seems to come off from the inner side of the *flexor perforans* tendon in its *upper* part, before it has been joined by the *flexor hallucis.* This last-named condition obtains in such birds as *Momotus, Merops,* and *Dacelo.*

When the hallux is absent, as well as in *Struthio* (where only two digits are present), the two tendons fuse completely in the leg, and the compound tendon is distributed in the usual way to the three (or two) digits. In many birds with a hallux, when there is no long flexor to that digit, the slip to it is extremely small; and in some cases it is altogether absent.

In the Trogonidæ, as might have been expected from the well-known peculiarity of their feet, an equally peculiar arrangement of the plantar tendons obtains (*l. c.* p. 345, fig. 6).

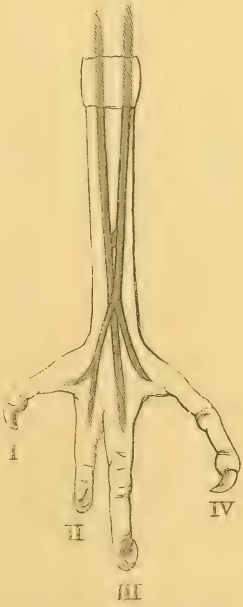
By far the most interesting feature, however, brought out by Prof. Garrod's investigations into this subject, is the discovery of the existence of two entirely different types of plantar arrangement in the so-called "zygodactyle" birds, as well as the fact that this diversity of type exactly coincides with the two groups of birds so marked out being respectively *"Homalo-"* and *"Anomalogonatous."* Thus, in the Parrots, Cuckoos, and Musophagidæ, which are all *Homalogonatous, possessing* (at least typically) the *ambiens* muscle, the plantar tendons are distributed in exactly the same way as in the common Fowl, the *flexor perforans* supplying digits II–IV, and the *flexor hallucis* digit I alone (neglecting the *vinculum*). In *all* the *Anomalogonatous* zygodactyle birds (which *all lack* the *ambiens* and *accessory femoro-caudal* muscles), namely the Picidæ, Capitonidæ, and their allies, Bucconidæ and Galbulidæ, an entirely unique arrangement is found; for in those birds the *flexor longus hallucis* splits up into *three* parts, *supplying digits* II and IV as well as the *hallux*, whilst the *flexor perforans digitorum* is distributed to the *third digit alone.* These differences in the two types will be clearly seen by comparing fig. 8 (*Crotophaga sulcirostris*) and fig. 9 (*Megalæma asiatica*).

Fig. 8.



Foot of *Crotophaga sulcirostris.*

Fig. 9.



Foot of *Megalæma asiatica.*

(From P. Z. S. 1875, p. 346, figs. 7 & 8.)

VI. *The Method of Insertion of the* Tensor patagii brevis *Muscle.*

In the patagial membrane of the wing in most birds there are two muscles present, the fleshy bellies of which arise chiefly from the scapular extremity of the furcula, whilst their tendons run between the two layers of membrane of which the *patagium* is composed. These muscles are the *tensor patagii longus* and the *tensor patagii brevis.* Arising in common, or in close proximity to each other, the tendon of the *tensor patagii longus* forms the more or less stiffened, though flexible, anterior border of the *patagium*; the tendon of the shorter of the two muscles runs more or less parallel with the humerus, ending near the elbow-joint. In different birds its insertion takes place in different ways, the tendon in some cases simply running straight on to the ulnar side, and there becoming blended with the general fascia of the part, whilst in others it becomes united, more or less intimately, with the tendinous origin, springing from a tubercle on the humerus, of a muscle lying on the radial side, the *extensor metacarpi radialis longior.* In some cases additional slips from the main tendon are given off, the arrangement sometimes thus getting very complicated (*e. g.*, in the Trogonidæ). As a rule, every natural family of birds has a characteristic arrangement of these tendons; so that their disposition often affords great help in classification. This is the case, for example, in the Passeres; throughout the whole of that immense group one arrangement, only slightly masked in one or two aberrant forms, which can be easily recognized and is most characteristic, obtains. The same is the case with the very closely allied groups of Picidæ, Ramphastidæ, Capitonidæ, and Indicatoridæ. These points were first worked out by Prof. Garrod in the first of his papers on Passerine birds*; and the arrangements in nearly all the families of his "Anomalogonatous birds" are there described and in several cases figured. In the Homalogonatæ, too, they offer nearly as well-marked peculiarities, though, unfortunately, his purpose of describing and figuring their arrangement in these birds was never carried out. In his MSS. and drawings, however, he has recorded their condition in very many groups.

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* P. Z. S. 1876, pp. 506–512, pls. xlviii.–li.

VII. *Certain other Muscles.*

In his paper on *Chauna* (*suprà*, p. 11), Prof. Garrod, for the first time, called attention to the value in classification of certain other myological facts. These are :—

(1) The presence or absence of the "*expansor secundariorum*" muscle.

This is a slender muscle which arises from the last few (generally two or three) secondary quills and has a peculiarly long and slender tendon, which, running superficially posterior to the humerus, together with the axillary vessels and nerves, is inserted into the thorax in different ways in different birds. One common arrangement is that found well developed in the Storks, and hence called "ciconiiform." Here the proximal part of the tendon is T-shaped, it splitting into two parts, one being inserted into the coracoid near the junction of this bone with the sternum, the other into the scapula close to the coraco-scapular articulation. In other cases the tendon may end by joining the *coraco-brachialis brevis* muscle, so as to appear to be part of that muscle, as in the Fowl and most of the Gallinaceous birds; or the tendons of the two sides may join in the middle line, as in most of the Anseres; or other and more complicated arrangements, duly described in the paper above referred to, may obtain. The only Anomalogonatous birds in which this muscle is present are the Coraciidæ. A table (*l. c.* p. 199) records the nature of this muscle in the families of Homalogonatous birds. In many it is quite absent.

(2) The presence or absence of a *biceps* slip to the *patagium* of the wing.

In many birds there is given off from the anterior margin of the *biceps* muscle of the arm a distinct and most peculiar muscular slip, which joins the patagial membrane of the wing. Its presence or absence is a very constant character amongst closely allied birds.

(3) The area of origin of the *obturator internus* muscle.

This muscle, arising in the interior of the pelvis, is inserted proximad of the *obturator externus* on the head of the femur. In most birds its shape, as seen in the pelvis, is more or less oval; but in some, as in the Gallinæ and Rails, it is distinctly *triangular*. Both its character and the presence or absence of a *bicipital slip* are recorded in the majority of the Avian families, in the table already mentioned in the account of the *expansor secundariorum*.

Besides these, a few other myological peculiarities insisted on by Prof. Garrod in various papers may here be named, such as the presence of an additional secondary femoro-caudal muscle in *Apteryx*, and the presence in it, as well as in the other "Struthious" birds and the Crypturi, of a muscular slip to the accessory femoro-caudal above the exit of the sciatic nerve and artery*; the occasional complete absence of the *semimembranosus* in some of the Grebes†; and the double condition of the great pectoral muscle in the Storks, Steganopodes, Petrels, and their allies‡.

VIII. *The Conformation of the Trachea and Syrinx.*

The curious contortions of the trachea, and other peculiarities of its structure, in various birds, such as the Cranes, Spoonbill, and Ducks, have long been known to ornithologists; and, as far as concerns this portion of the subject, Prof. Garrod's notes on these structures in various forms§ are simply confirmations of, or additions to, our previous knowledge of the subject. But, so far as I am aware, little or no attention had ever previously been paid to the details of modification in the cartilaginous or ossified tracheal and bronchial structures concerned in the formation of the hard framework of the lower larynx, or "syrinx." Garrod's investigations into this subject therefore mark a new line of departure; and it is exceedingly to be regretted that only one part of his notes on the subject were completed before his death, these forming his paper "On the Conformation of the Thoracic Extremity of the Trachea in the Class Aves.—Part I. The Gallinæ"[*], the last contribution of his pen to ornithological science. There is every reason to believe that this line of research, when prosecuted further, will lead to most valuable results as a means of separating, on anatomical grounds, allied genera or families of birds[†]. Of his investigations of the lower larynx of the Passeres I propose to speak later, under that head.

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* P. Z. S. 1873, pp. 643, 644, fig. 6.

† P. Z. S. 1873, p. 629, 642.

‡ P. Z. S. 1874, p. 120, and 1876, p. 340.

§ "On the Form of the Lower Larynx in certain Species of Ducks," P. Z. S. 1875, pp. 151–156 (the species described are *Sarcidiornis melanonota*, *Rhodonessa caryophyllacea*, and *Metopiana peposaca*); "On the Form of the Trachea in certain Species of Storks and Spoonbills," P. Z. S. 1875, pp. 297–301 (*Tantalus ibis* and *Platalea ajaja*); "On the Trachea of *Tantalus loculator* and of *Vanellus cayennensis*," P. Z. S. 1878, pp. 625–629.

In the remaining part of this paper I propose to consider the results arrived at, from the consideration of these and other anatomical features, by Prof. Garrod as to the relationships of various obscure forms of birds, and also to describe certain remarkable peculiarities of others as first discovered by him. In these remarks, as before, I shall, for convenience sake, follow, as nearly as possible, a chronological order, reserving, however, till the last any general views on the classification of birds as a whole.

1. *Struthio*[‡].—In this paper, written in conjunction with Mr. Frank Darwin, the principal point of interest is the discovery, or, at all events, first notice, of a peculiar nodule of bone lying on the centre of the pubis, and, in some respects,

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✓ [*] P. Z. S. 1879, pp. 354–380, figs. 1–35.

[†] A second part of Garrod's notes on the trachea, describing that of the Cuculidæ, I found in a nearly complete state amongst his MSS., as well as a very considerable mass of drawings and notes on this subject in other groups, it having been the special object of his study up to within a very few weeks of his death. Indeed, during all his last illness, when too weak to attend to larger and less convenient objects, he continued to work away with all his old enthusiasm and energy at the windpipes of birds, especially those from the extensive collection of Procellariidæ &c. made by H.M.S. 'Challenger.'

[‡] "Notes on an Ostrich lately living in the Society's Collection," P. Z. S. 1872, pp. 356–363.

similar to the "marsupial" bone of the Implacental Mammalia and its corresponding fibrous representative in certain Carnivora.

2. *Heteralocha*[*].—In 1872 the true affinities of the Huia bird were quite uncertain, many authorities placing it amongst the Hoopoes (Upupidæ). From an examination of the specimen that lived in the Zoological Society's Gardens, Prof. Garrod was enabled to show that it was truly Passerine, and not only so, but in many respects so peculiarly *Sturnine*[†] as to entitle it to a place "at the head of the family."

3. *Steatornis*[‡].—Besides the myology and visceral anatomy, the pterylosis, skull, and syrinx (which is "bronchial") are particularly described and figured. The result arrived at, as regards the systematic position of *Steatornis*, is that it must form a family by itself, with strong affinities to the Owls, Caprimulgidæ, and Coraciidæ and their allies.

4. *Columbæ*[§].—In these papers the number of the rectrices (varying from twelve to twenty in different genera), together with the presence or absence of the oil-gland, of the cæca, and of the ambiens muscle, is recorded in a large number of forms, and, from the various combinations of characters so obtained, an attempt is made to divide up the group of Pigeons, in which are included the Pteroclidæ, in a more natural way than has hitherto been done. Attention is also called to the characteristic form of the humerus in these birds, as well as to the peculiar form of the gizzard in the genus *Ptilopus*, there being here *four* crushing-pads, instead of two as in all other birds, including even *Treron*.

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[*] "Notes on the Anatomy of the Huia Bird (*Heteralocha gouldi*)," P. Z. S. 1872, pp. 643–647.

[†] Mr. Sharpe must, we fear, have overlooked this paper of Prof. Garrod's, as he still retains *Heteralocha* amongst the Corvidæ (Cat. Birds, iii. p. 143), quite in opposition to the conclusions above stated.

[‡] "On some Points in the Anatomy of *Steatornis*," P. Z. S. 1873, pp. 526–535.

[§] "On some Points in the Anatomy of the *Columbæ*," P. Z. S. 1874, pp. 249–259; "Notes on two Pigeons, *Ianthænas leucolæma* and *Erythrænas pulcherrima*," P. Z. S. 1875, p. 367; "Note on the Gizzard and other Organs of *Carpophaga latrans*," P. Z. S. 1878, pp. 102–105.

In *Carpophaga latrans* the stomach is even more peculiar; for here the epithelial lining of the gizzard is developed into about two dozen horny conical processes, like the tubercles of a *Cidaris* or similar Sea-urchin. A similar condition has been described by MM. Verreaux and Des Murs in *C. goliath* of New Caledonia*; but no other species of *Carpophaga* yet examined shows any trace of such a structure.

5. *Psittaci*†.—In these papers, as in the last, the condition of certain structures is recorded in a large number of forms, and from the *combinations* of characters so obtained a scheme of classification is sketched out, each group having assigned to it a formula stating its most essential characters. The presence or absence of the ambiens muscle, of a furcula, and of an oil-gland are the points here laid stress on, together with the condition of the carotid arteries. Of these there may be either two normally situated, or only one, the left (*Cacatua* and *Licmetis tenuirostris*), or two, the *left* of which, instead of running with its fellow in the hypapophysial canal, as already explained, runs *superficially* up the neck with the left *vagus* nerve and jugular vein. This last condition, which obtains *in no other birds*, is considered, as I think rightly, sufficiently important to divide off as a main group of Psittaci all those possessing it—a group including *all* the American Parrots, together with the Platycercidæ (including *Lathamus*), *Nestor*, *Dasyptilus*, and the African Parrots, other than *Agapornis* and *Palæornis*, of the Old-World forms. The further subdivision of these groups is effected in the way already indicated. In a supplementary note attention is called to the probably invariable presence of a gall-bladder in the *Cacatuinæ*, though this organ has not been found in any other Parrots.

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* This has lately been described at greater length and figured by M. Viallane (Ann. Sc. Nat. ser. 6, vii. art. no. 12).

† "On Points in the Anatomy of the Parrots which bear on the Classification of the Suborder," P. Z. S. 1874, pp. 586–598, pls. lxx., lxxi. "Notes on the Anatomy of certain Parrots," P. Z. S. 1876, pp. 691, 692; "Note on the Absence or Presence of a Gall-bladder in the Family of the Parrots," P. Z. S. 1877, p. 793.

In a preceding paper* Prof. Garrod has described and figured the tongue of *Nestor*, which, as he shows, is peculiar, and *not* like that of the Lories, with which it has often been associated.

6. *Otididæ*†.—In *Eupodotis australis* there is *not*, as had been supposed, and even stated‡, by previous observers, a gular pouch, such as has been seen in *Otis tarda*. On the contrary, the *œsophagus* is highly *distensile*, and so produces the singular appearance of the males of this bird when excited during the breeding-season. In a young male specimen of *Otis tarda* examined, there was also no gular pouch present; but the *frænum linguæ* was double; and it is suggested that the pouch which *has* been found in the males of that species is due to a rupture and distention of the mucous membrane between this duplicate frænum, owing to the inflation of the air-passages during the period of display.

7. *Chauna*§.—The pterylosis, visceral anatomy, myology, and cranial and other characters of the Derbyan Screamer are here fully described. The very peculiar nature of the alimentary canal, in the glandular parts of the *proventriculus* forming, not a zone, but a patch, as well as in its possession of long *sacculated* cæca, without any spiral valve, which open into a special division of the intestine situated between the colon and the ileum, is particularly worthy of notice, *Chauna* ‖ being absolutely unique amongst birds in this combination of characters. In its pterylosis and syrinx, too, it is very peculiar. As a result of his examination, Prof. Garrod concludes that the *Palamedeæ* cannot be placed amongst the Anseres, as had been done by Professors Parker and Huxley,

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* "Note on the Tongue of the Psittacine genus *Nestor*," P. Z. S. 1872, pp. 787–789.

† "On the 'Showing-off' of the Australian Bustard," P. Z. S. 1874, pp. 471–473; "Further Note on the Mechanism of the 'Show-off' in Bustards," P. Z. S. 1874, pp. 673, 674.

‡ Ibis, 1862, p. 114.

§ "On the Anatomy of *Chauna derbiana*, and on the Systematic Position of the Screamers (Palamedeidæ)," P. Z. S. 1876, pp. 189–200, pls. xii.–xv.

‖ The anatomy of the soft parts of *Palamedea* is still, I believe, almost unknown.

but must form an independent group of birds, having probably "sprung from the primary avian stock as an independent offshoot at much the same time as did most of the other important families."

8. *Aramus**.—In the schizorhinal character of its skull, as well as in the presence of occipital foramina, *Aramus* resembles *Grus, Ibis, Platalea,* and the Limicolæ, and not the Rallidæ, with which it had generally been associated previously; and this collocation is quite confirmed by its myology and visceral anatomy.

9. *Plotus*†.—In the first paper the anatomy of *P. anhinga* is described at considerable length—particular stress being laid on the curious arrangement of the cervical vertebræ which makes this bird literally *unable* to carry its neck straight, and the correspondingly modified muscular system. Other points described are the presence of but *one* carotid artery, and of but *one* cæcum—the latter a feature previously unknown in any Steganopodous bird, though constant in the Herons. The most interesting feature, however, of *Plotus anhinga* is its very extraordinary stomach, previously only partially described by Macgillivray. The *proventriculus,* instead of forming a zone or patch, is here developed into a special sac-like *diverticulum,* which projects from the gizzard externally in a way quite unlike that of any other bird. Moreover the pyloric compartment of the stomach, which is present in a less complete form in *Pelecanus,* the Herodiones, Falconidæ, &c., here develops a covering of hairs, "a peculiarity which, as far as I know, is found only in one other bird, namely *Cathartes aura.*" This very extraordinary stomach is figured on plate xxviii., and is certainly, as far as yet known, unique amongst birds. In *Plotus levaillanti* the same features in its anatomy generally are present as in *P. anhinga.* But there are, as usual, two small cæca: and its stomach differs considerably; for here there is no proventricular gland-pouch, but this

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* "On the Anatomy of *Aramus scolopaceus,*" P. Z. S. 1876, pp. 275–277.

† "Notes on the Anatomy of *Plotus anhinga,*" P. Z. S. 1876, pp. 335–345, pls. xxvi.–xxviii.; "Note on Points in the Anatomy of Levaillant's Darter (*Plotus levaillanti*)," P. Z. S. 1878, pp. 679–681.

organ, as in some other birds, assumes the form of two separate patches. The second (pyloric) compartment of the stomach is also present, in a well-developed form, and is also hair-clad. But here another difference presents itself; for "the hairy epithelium surrounding the pyloric orifice . . . . is produced into a considerable conical hair-covered process, projecting into the second stomach, and evidently acting as a valve to close the pylorus when necessary." These differences in two species so closely allied in all other points show that, though in nine cases out of ten similarity of external characters predicates similarity of internal structure, nevertheless in the tenth the correspondence breaks down, and that, too, without any obvious differences in mode of life, food, &c. The parallel, pointed out by Prof. Garrod, presented by these two species of *Plotus* with the two living genera of Sirenia (*Manatus* and *Halicore*), as regards the modification of their gastric gland-structures, is particularly interesting.

10. *Coliidæ**.—The skull of *Colius* is desmognathous, and has no vomer, as in *Alcedo*. The viscera and myology do not bear out the idea of any relationship to the Parrots or Musophagidæ; on the contrary, these birds are truly Anomalogonatous, and are most nearly related perhaps to the Alcedinidæ and Bucerotidæ. Nevertheless their combination of characters fully substantiates their claim to form a separate family, Coliidæ.

11. *Thinocoridæ*†.—These birds, in their schizorhinal skull, and in many other features, visceral and myological, resemble most some of the more aberrant forms of Limicoline birds, such as *Cursorius* and *Glareola*. Attention is also drawn in this paper to the very extensive variations in the form of the vomer in various Charadriiform birds, it being (so far from always "tapering to a point anteriorly," as it *should* [?] do in these "schizognathous" birds) in several forms extraordinarily *broad* or even widely *emarginate* anteriorly!

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* "Notes on the Anatomy of the Colies," P. Z. S. 1876, pp. 416–420.

† "Notes on the Anatomy and Systematic Position of the Genera *Thinocorus* and *Attagis*," P. Z. S. 1877, pp. 413–418.

12. *Momotidæ*[*].—The colic cæca being absent, at the same time that, except in *Momotus*, the oil-gland is tufted, the Momotidæ must be placed amongst the Piciform series of Anomalogonatæ, close to the Todidæ, and not with the Coraciidæ amongst the Passeriformes. The syrinx and some other points in their anatomy are also described.

13. *Megacephalon*[†].—A short paper describing the pterylosis (hitherto almost unknown in the Megapodidæ), syrinx, and other points in this peculiar form, which is perfectly gallinaceous.

14. *Indicator*[‡].—In its pterylosis, visceral anatomy, myology, and osteology, *Indicator* closely approaches the Picidæ, Capitonidæ, and their allies, and is in no respect Cuculine. Its vomer is large and strongly bifurcate anteriorly, as in the *Capitoninæ*; of the latter some are desmognathous, others, as in *Indicator*, not. The truncated vomer of *Ramphastos* is also figured. In conclusion it is suggested that *Indicator* should form but a subfamily, to be comprised, together with the *Ramphastinæ* and *Capitoninæ*, in a larger group, the Capitonidæ.

15. *Opisthocomus*[§].—*Opisthocomus* is a true Homalogonatous bird, having both the *ambiens* and accessory femorocaudal muscles; it cannot, therefore, have any thing to do with the Passeres. It is, perhaps, most nearly related to the Gallinæ, but, at the same time, can hardly be included with them; it is also not far from the Cuculidæ and Musophagidæ, helping thus to fill up the gap that now exists between these latter families and the Gallinaceous birds.

16. *Passeres*[||].—To define by anatomical characters super-

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[*] "On the Systematic Position of the Momotidæ," P. Z. S. 1878, pp. 100–102.

[†] "On the Anatomy of the Maleo," P. Z. S. 1878, pp. 629–631.

[‡] "Notes on the Anatomy of *Indicator major*," P. Z. S. 1878, pp. 930–935.

[§] "Notes on Points in the Anatomy of the Hoatzin," P. Z. S. 1879, pp. 109–114.

[||] "On some Anatomical Characters which bear upon the Major Divisions of the Passerine Birds:" Part I., P. Z. S. 1876, pp. 506–519, pls. xlviii.–liii.; Part II., P. Z. S. 1877, pp. 447–452; Part III., P. Z. S. 1877, pp. 523–526, pl. liii.; Part IV., P. Z. S. 1878, p. 143.

generic groups in the immense mass of Passerine birds was always a favourite object with Prof. Garrod; and the four papers quoted above* are the published results of his efforts at a solution of the difficulties that have always attended the classification of this group. It was whilst working at Passerine birds that the classificatory value of the mode of termination of the tendon of the *tensor patagii brevis* muscle, already alluded to (*suprà,* p. 16), first attracted his attention. The presence also in certain Passerine birds, the Cotingidæ and Pipridæ, of a femoral instead of a sciatic artery has also been mentioned. A slight exception, too, to Sundevall's generalization about the independent muscular supply of the *hallux* in Passerine birds (*suprà,* p. 13) was found by him to exist in the Eurylæmidæ (P. Z. S. 1877, p. 447). But the most novel fact pointed out by Prof. Garrod as regards these birds is that they may be divided into two main groups, according as to whether the intrinsic muscles of the syrinx are inserted into the *ends* or into the *middle* of the bronchial semirings. The former group, called by him *Acromyodi,* includes all the ordinary singing-birds with four or five pairs of muscles, the Oscines, together with two aberrant Australian groups, formed by the genera *Menura* and *Atrichia.* In these the number of intrinsic muscles is reduced to three and two pairs respectively; but they are still inserted into the *tips* of the semirings †.

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* Together with his appendix to the English edition of Johannes Müller's 'Stimmorgane der Passerinen.'

† I may here remark that I cannot at all agree with Mr. Sclater's view on the position of these two genera, which form his group "Pseudoscines" (Ibis, 1880, p. 345). By placing *Atrichia* and *Menura* away from the other Acromyodian Passeres, and interpolating the Mesomyodian ones, the important fact is ignored that, in their possession of an "Acromyodian" syrinx, these birds depart essentially from the typical avian "Mesomyodian" structure, the one which there cannot be the slightest doubt is the more primitive form. "The much more important osteological characters" in which these two forms are said to diverge from the other Passeres are, as far as I am aware, two only; and these, moreover, are individual peculiarities of each genus, and by no means common to the two forms—in *Menura* the curved posterior margin of the sternum,

The other group, the *Mesomyodi*, have the intrinsic muscles (which are usually reduced to a single pair, one on each side) inserted into the *middle* of the rings. In them, too, the tenth ("first") primary is always more or less long, and the tarsus, with trifling exceptions, not "bilaminate." They nearly correspond to the "Formicarioid" Passeres of Wallace, except that Wallace included in that group the Acromyodian, though in some respects aberrant, *Menura*. The Mesomyodi include all the Tracheophone Passeres, together with the Pipridæ, Cotingidæ, Tyrannidæ, Pittidæ, and a few smaller groups. A further division of these two main groups is given by Prof. Garrod in the first paper quoted (*t. c.* p. 518), the smaller divisions being based on one or other of the other characters already noticed. A considerable number of the previously unknown syringes of Passerine birds were described by him for the first time in one or other of the above communications, amongst which those of *Pitta* and *Atrichia* are particularly noticeable. The peculiar form of the nasal bones in certain of the Tracheophonæ, so that these birds are to this extent "schizorhinal," has already been mentioned when speaking of that character, as has also the paper on *Heteralocha*.

It is much to be regretted that Prof. Garrod did not live to make public his maturer views on the difficult subject of the general classification of birds. The only published scheme of any such classification is to be found in part ii. of his paper on the Thigh-Muscles (*suprà*, p. 8); and it is within my knowledge that he had already seen reason to deviate in some respects from the arrangement

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in *Atrichia* the absence of clavicles (Garrod, P. Z. S. 1876, p. 516). As is now well known, Prof. Huxley's original description of the skull in *Menura* (P. Z. S. 1867, p. 472) was founded on a misconception of its structure, apparently owing to the imperfection of his specimen (*cf.* Parker, Trans. Z. S. ix. pp. 307, 308). Moreover the "most anomalous forms of Passerine birds yet known," or at all events the most generalized, are, according to the views of Garrod and myself, certainly the Eurylæmidæ, which last therefore, and not the "Pseudoscines," should be placed at the end, in a descending scale, of the Passerine series.

there adopted. Nevertheless I think I may say he was satisfied to the last as to the naturalness of the two main groups into which he there divided birds, the "Homalogonatæ" and the "Anomalogonatæ." It is often assumed that this division rests only upon a single character, namely the presence or absence of the ambiens muscle. As a matter of fact this is *not* the case; for the ambiens muscle is absent in many birds that are ranked amongst the Homalogonatæ. What Prof. Garrod says is this:—"The oft-named *ambiens* muscle is, in my mind, the *key* to the whole," and that, not because of its own intrinsic importance, but because its presence is always associated with peculiarities in other parts never found in any Anomalogonatous bird. That the same combinations of three or four different characters should have arisen *independently* in different birds is so extremely improbable, that we can hardly ascribe these similarities in combinations of characters to any other cause than to blood-relationship, the expression of which is now unanimously accepted as the true end of all biological classifications.

"The facts disclosed by a study of the myology of birds *do not*, without extraneous assistance, place the families in their true relationship to one another. Because the same muscles are present in two families of birds, it cannot therefore be said that their kinship is extremely close, or the reverse . . . . It is therefore necessary to look around to find, if possible, myological characters which have some definite relations to equally well-marked pterylographic, visceral, or osteological peculiarities" (P. Z. S. 1874, p. 114). As already insisted on, it was in this combination of characters that Prof. Garrod trusted to find the true "key" to the question.

To return to facts,—no bird which is "Anomalogonatous" has ever an accessory femoro-caudal muscle; that is, the letter B never enters its formula. Again, no bird that is Anomalogonatous has ever a tufted oil-gland *and* cæca, though this combination is nearly always found in the Homalogonatous birds. So much so is this the case, that there are only nine groups of Homalogonatous birds that have *not* this mentioned combination[*], and in two of these the exception is caused by the entire absence of the oil-gland (in the Otididæ and the Struthiones). Of the remaining seven, in which the cæca and a tufted oil-gland are not correlated, I find, by tabulation, that four always have the ambiens muscle developed, whilst the remaining three have it present in at least some of their members. Of these latter, moreover, two have the accessory femoro-caudal (B) always present; so that it is only *certain* Parrots which have a formula like that of any anomalogonatous bird (for it must be remembered that in several Parrots the ambiens muscle *is* present). This fact will be made clearer by the accompanying table, containing the names of the three main groups of the Anomalogonatæ,

	Ambiens.	Accessory femoro-caudal.	Tuft to oil-gland.	Cæca.
Anomalogonatæ.				
Cypseliformes	−	−	−	−
Passeriformes	−	−	−	+
Piciformes	−	−	± [†]	−
Exceptional Homalogonatæ.				
Megapodidæ	+	+	+	−
Thalassidrominæ	±	+	+	−
Musophagidæ	+	+	+	−
Psittacidæ	±	−	+	−
Columbidæ	±	+	−	±
Cuculidæ	+	±	−	+
Cathartidæ	+	−	−	−
Other Homalogonatæ	±	±	+	+

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[*] One or two genera in various families, as e. g. *Cancroma*, have also lost the oil-gland tuft. As, however, all the allied genera retain it, these slight exceptions in no way invalidate Prof. Garrod's argument.

[†] In *Momotus* the tuft is absent.

followed by those of the seven groups above mentioned as the exceptions to the combination of cæca and a tufted oil-gland amongst the Homalogonatæ.

Thus, of the whole series of Homalogonatous birds, not one, except certain Parrots (the most specialized, no doubt, of all that series), has any combination of these characters that could lead to its inclusion with the three combinations present in the Anomalogonatæ.

The grand division into Homalo- and Anomalogonatæ was primarily made by Mr. Garrod on the strength of the facts here tabulated. But subsequent investigations of quite different points have much strengthened his original position. One of these is the difference in distribution of the plantar tendons in the two groups of zygodactyle birds, already described above. I believe the removal of the Cuculidæ and Musophagidæ from the so-called "Picarian" birds, or "Coccygomorphæ," on account of their possessing the ambiens muscle, absent in the others, was considered by many naturalists a striking proof of the artificial nature of Prof. Garrod's system. But it has been most remarkably confirmed by his later discovery, and so is, to my mind, one of the most convincing proofs of the correctness of his arguments, until, at least, some other explanation shall be given of the facts here adduced. Yet another confirmation is afforded by the pterylosis. I here reproduce Prof. Garrod's own words:—"My study of pterylography has led me to look upon the nature of the dorsal tract as all important in determining to which great group of birds, the Homalogonatæ or Anomalogonatæ, any doubtful family belongs. When the dorsal tract develops a fork *between* the shoulders, a bird is Homalogonatous; when the tract runs on unenlarged to near the lower ends of the scapulæ, then it is Anomalogonatous" (P. Z. S. 1878, p. 931).

Very few exceptions to this rule obtain—the Coraciidæ, in that they develop an interscapular fork, although in other respects truly Anomalogonatous, being, perhaps, the most marked one.

The Homalogonatous nature of the Cuculidæ is fully born out by their pterylosis, the dorsal tract in them dividing between the scapulæ. In the Musophagidæ the pterylosis above is peculiar, and gives no aid in determining their affinities. The Strigidæ, Caprimulgidæ, and *Steatornis* are, judged by this criterion, *Homalogonatous,* although in them the ambiens and accessory femoro-caudal are absent, at the same time that they have cæca and a nude oil-gland. But the very difficult question of the true affinities of these groups was one on which Prof. Garrod had not finally made up his mind.

Leaving these three groups aside, the following is the arrangement adopted by Prof. Garrod of his "subclass" Anomalogonatæ.

PICIFORMES.	PASSERIFORMES.	CYPSELIFORMES.
Oil-gland tufted.	Oil-gland nude.	Oil-gland nude.
Cæca absent.	Cæca present.	Cæca absent.
External branch of pectoral tract given off at commencement of breast [*].	Pectoral tract simple, or with the external branch given off beyond middle of breast.	
(A) X Y.	A X (Y).	A.
Picidæ.	Passeres.	Macrochires.
Capitonidæ [†].	Bucconidæ (?).	
Upupidæ.	Galbulidæ.	
Bucerotidæ.	Coraciidæ.	
Coliidæ.	Meropidæ.	
Alcedinidæ.	Trogonidæ.	
Momotidæ.		

As regards the Homalogonatæ, these were divided (P. Z. S. 1874, p. 119 &c.) into four orders, the Galliformes, Anseriformes, Ciconiiformes, and Charadriiformes, the latter including all the Homalogonatous schizorhinal birds. The further subdivisions of these will be found in Prof. Garrod's paper as quoted, and need not be repeated here.

The Strigidæ, there included with the Falconidæ amongst the "Ciconiiformes," would almost certainly, in a revised arrangement, have been removed from there and placed elsewhere. The Tubinares, or Petrels and Albatrosses, placed with the "Anseriformes," were found, on further examination, to be far nearer the Ciconiiform birds; and in the unfinished paper on *Pelecanoides* already alluded to, the reasons for this change were to have been given, the shortness of the cæca and the double great pectoral muscle being two of the facts adduced in favour of it.

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[*] P. Z. S. 1878, p. 931.

[†] Including the *Ramphastinæ* and *Indicator* (*t. c.* p. 935).

In this imperfect sketch of my lamented friend's ornithological work, I hope I have succeeded in showing my fellow members of the B. O. U. and others that Garrod's work and generalizations did not depend upon any single character or set of characters. No man probably has ever yet enjoyed such opportunities or ample material for research in any single group of animals as he did; and he had, in addition, the advantage of all the work previously done on the subject, the value of which was duly estimated by him in forming his own conclusions. He came to the question of the classification of birds quite fresh, with none of those prejudices on the subject which are nearly inevitable amongst those who have worked at birds in their early days and so imbibed more or fewer of the traditional ideas on the subject. In addition, he had had all the advantages of a regular medical and scientific education, and was therefore the less likely to be tempted into rash generalizations or led away by crude theories. This much is certain: no future attempt to classify birds can omit to take into consideration the contributions to this subject made by the brilliant genius of our late member, which will always remain as a lasting tribute to his memory.

II.—*Descriptions of two new Species of Birds.* By Captain R. G. Wardlaw Ramsay, F.Z.S. &c., 67th Regiment.

(Plate I.)

Two apparently distinct species of the genus *Analcipus*, Swainson, have hitherto been treated as identical, viz. the Black-and-crimson Orioles of Sumatra and Java.

The title *A. cruentus* (Wagler), Syst. Av. addit. sp. 9, has been equally applied to the birds from both islands, as well as to those from Borneo; but this title must be retained